Responses to Follow-up Missouri Department of Health and Senior Services, Missouri Department of Natural Resources, and U.S. Environmental Protection Agency, Region 7 Comments on the Draft Final Feasibility Study Report for the St. Louis Ordnance Plant, Former Hanley Area

July 2, 2010

This document provides Army responses to follow-up comments from the Missouri Department of Health and Senior Services (MDHSS), Missouri Department of Natural Resources (MDNR), and U.S. Environmental Protection Agency, Region 7 (USEPA) on the document referenced above. On behalf of the regulators, MDNR submitted follow-up comments to the Army on June 24, 2010. The follow-up comments were made following submittal of Army redline responses to regulator comments on June 10, 2010.

MDHSS – Response to Comment 9

MDHSS is not satisfied with the Army's response on using MCLs for the groundwater screening levels for the vapor intrusion evaluation. MDHSS recommended that screening levels be developed to be protective of indoor air. However, as the Army responded, based on the shallow depth to groundwater, the Johnson and Ettinger Model is not recommended to be used to back-calculate target groundwater concentrations protective of indoor air. Additionally, since the water table is very shallow, very little attenuation is likely to occur in the vadose zone and in such cases, using a screening level based on a generic attenuation factor may not be adequately protective.

The Army's response claims that MCLs are protective for the vapor intrusion pathway and their response specifically states, "Although the MCL was not developed with the vapor intrusion pathway in mind, it is assumed to be overly conservative (i.e., protective) for the vapor intrusion pathway since USEPA has determined, on a federal level, that MCLs are protective of inhalation exposures in the shower, which are more intensive inhalation exposures than those that may result from groundwater volatilization and subsequent intrusion through a building foundation." MDHSS questions this and requests that the Army substantiate this statement with references.

In addition, the agencies have recommended subslab soil gas sampling. While an attempt has made to collect soil gas samples, no attempt has been made to collect subslab samples. Given the uncertainty of this pathway and the problems with assessing vapor intrusion in areas of shallow groundwater, MDHSS again recommends subslab soil gas sampling be incorporated into the planned vapor intrusion evaluation.

Army Response

The Army acknowledges MDHSS's questions regarding the rationale for using USEPA maximum contaminant levels (MCLs) for screening in a vapor intrusion assessment.

Additional support for this rationale and clarifications to the Response to Comment 9 are provided here.

Although not stated in the original response, the initial reason for considering MCLs in the vapor intrusion screening process was based on USEPA's decision to use MCLs in the 2002 draft vapor intrusion guidance (EPA530-D-02-004). In the guidance, MCLs were used in the generic groundwater-to-indoor air screening level tables. Since 2002, USEPA has been supplementing an empirical database used to develop the screening levels. USEPA released an updated version of the database in 2008, which is available for download on their website (http://www.epa.gov/oswer/vaporintrusion/vi_data.html). A review of the paired groundwater and indoor air concentrations listed in the 2008 database supports the conclusion that groundwater concentrations at or below MCLs do not result in significant vapor intrusion impacts.

Since the release of USEPA's 2002 draft guidance, none of the empirical data presented by USEPA or others during vapor intrusion specialty conferences/workshops/sessions[1] support the conclusion that significant groundwater-to-indoor air vapor intrusion impacts occur at concentrations at or below MCLs.

Additionally, USEPA's Risk Assessment Forum concluded in a July 10, 1991 Memorandum from Dorothy E. Patton to Henry Habicht that inhalation risks associated with volatilization during showering are no greater than the drinking water pathway. It is reasonable to assume that USEPA considered the risks associated with showering and volatilization during the development of MCLs. Note also that showering provides a direct preferential pathway for volatiles to enter a building via the household water line and subsequent volatilization and that the volatilization risks during showering are assumed to be significantly greater than those associated with VOCs that volatize from groundwater beneath a building and attenuate by a factor of at least one-in-one-thousand (USEPA 2002 generic default) or more as they migrate into indoor air.

The Army acknowledges MDHSS's request for subslab sampling. However, the Army maintains that these samples are unnecessary because of indoor air samples that were collected from [redacted] in 2008. The highest indoor air concentration of trichloroethene (TCE) in the residence was 1.1 micrograms per cubic meter ($\mu g/m^3$; March 2008). This concentration falls below the residential indoor air screening level for TCE (1.2 $\mu g/m^3$) that USEPA published in a May 2010 update to their Regional Screening Levels[2].

The Army is not ruling out the possibility of collecting subslab samples in the future, but it would not consider doing so unless evidence of a vapor intrusion concern emerges, such as increasing VOC concentrations in groundwater monitoring wells along Stratford Avenue. In such a situation, the Army may forego additional sampling and proceed directly to a mitigation action at the affected residence(s).

[1] http://iavi.rti.org/WorkshopsAndConferences.cfm

[2] http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

MDNR Response to Comments

Five Year Review (FYR) - This statement still sounds like we are obligated to end the FYR when we reach the clean up values for the sites; and typically, CERCLA sites require at least have one post clean up FYR. It is suggested that the following lines be edited as recommended:

- "*The fiver-year reviews will be terminated once the following occur:* " becomes "*Remedy completion reports will be submitted-for regulator approval once the following occurs:*"
- "*Once these conditions are confirmed at the former Hanley Area, the five-year reviews will be terminated in coordination with state and/or federal government with approval of MDNR and in consultation with USEPA.* " becomes "*Once the clean up objectives have been met at the former Hanley Area, the five-year reviews may no longer be necessary upon coordination with regulators.*"

Army Response

USEPA's April 2003 guidance, Five-Year Review Process in the Superfund Program, states the following:

> Five-Year Reviews continue throughout the life of the site until hazardous substances, pollutants or contaminants no longer remain on site at levels that do not allow for unlimited use and unrestricted exposure. The basis for this finding should be documented in the final Five-Year Review report.

To maintain consistency with the guidance, the FS text will be revised as follows (bold underlined text corresponds to revisions to the Army's response dated June 10, 2010):

"*The 5-year reviews will take place until the following occur:*

- *COCs are at or below the remediation goals*
- *the vapor intrusion pathway is determined not to cause unacceptable risk as part of a future vapor intrusion evaluation (or chemical concentrations in groundwater fall below screening levels),*
- *monitoring confirms that no unacceptable risks are posed by Plume C. Confirmation will consist of demonstrating that groundwater in Plume C remains deeper than 10 feet below the ground surface or that concentrations within the plume have fallen below remediation goals.*

Once these conditions are confirmed at the former Hanley Area, the 5-year reviews will be recommended for termination. The basis for the recommendation will be documented in a final 5-Year Review Report that will be submitted for regulatory approval."

EPA - Response to Comments

Land Use Controls &.Land Use Control Implementation Plan - For clarification this is the deed restriction plan discussed in the teleconference call correct? Is there a projected time line for this plan? It is believed this plan should be done prior to the ROD.

Army Response

The land use control implementation plan (LUCIP) was discussed during the May 10, 2010 teleconference. It will define site-specific LUCs, establish their boundaries, and explain how they will be implemented and monitored. This information will be memorialized in the property deed upon transfer of property ownership.

The LUCIP is normally developed after the decision document and concurrently with a long-term management plan. The decision document is prepared first as it is a legal document that establishes the requirement for LUCs. The LUCIP then provides the details regarding LUC implementation and monitoring.

Responses to Follow-up U.S. Environmental Protection Agency, Region 7 Comments on the Draft Final Feasibility Study Report for the St. Louis Ordnance Plant, Former Hanley Area

June 7, 2010

This document provides Army responses to the U.S. Environmental Protection Agency, Region 7 (USEPA) comments on the document referenced above. USEPA submitted follow-up comments to the Army on May 18, 2010. The follow-up comments were made following submittal of Army responses to original USEPA comments on April 22, 2010.

USEPA Specific Comment 2

Section 2.0: What extent of statistical trend analysis has been performed for the multiple years of groundwater data to evaluate if the site plumes are increasing, decreasing, stable, or if there is no observable trend?

Army Response

During the RI, a plume stability analysis was performed using the REMChlor model. Please refer to Section 2.4.4 in the Draft Final FS report for a discussion of the modeling findings.

USEPA Follow-up Comment

Section 2.4.4 presents a discussion relative to plume stability analysis based on the REMChlor model. However, the original comment is in reference to the performance of a statistical trend analysis such as the Mann Kendall Test, which is a non-parametric statistical test and trend estimator that can be used to prove if contaminant concentrations are significantly diminishing or rising over time, or the similar Sen's Test. As an additional line of evidence, please perform the Mann Kendall Test on the groundwater data for the site to evaluate the trends in concentrations (if any) in the groundwater.

Army Response

It is not possible to perform the tests that the reviewer references above because groundwater samples have only been collected on two occasions: in 2007 and 2008. The Army acknowledges that additional sampling is needed to assess plume stability and plans to sample the wells again in 2010. Groundwater data from 2007, 2008, 2010, and future events described in the FS report will support an evaluation of plume stability.

USEPA Specific Comment 4

Section 2.3.5, Page 2-4: Add a sentence or two that summarizes the levels of contamination to be addressed as part of the powder well sediment removal action.

Army Response

As stated in Section 2.3.5, sediment will be removed from the powder wells as part of the remedial action. The levels of powder well sediment contamination are not relevant because the remedial action will remove the sediment in the powder wells. Sediment samples will be collected for waste characterization purposes only.

USEPA Follow-up Comment

While there is no disagreement that the levels of contamination in the sediment in the powder wells will not impact the proposed removal action, this information is relevant information and should be included in the document. Please revise the text as requested.

Army Response

The following text will be added at the beginning of Section 2.3.5:

> *In 2001, 22 powder wells were located across the former Hanley Area. Eighteen of the wells contained sediment with various metal concentrations exceeding conservative risk-based screening levels defined in the RI report (CH2M HILL 2009a). Explosives in powder well samples were not detected at concentrations above the screening levels.*

USEPA Specific Comment 6

Figure 2-6: MW-110 shows detection limits in excess of maximum contaminant levels (MCLs). Please revise the results for this well to bold and shadow these detection limits.

Army Response

The Army acknowledges that detection limits for some undetected chemicals in MW-110 and other monitoring wells exceeded screening values for groundwater. Such instances occurred in samples that were diluted during analysis because of elevated concentrations of other VOCs. Because uncertainty exists regarding whether the non-detected chemicals are actually present at levels above MCLs, it is not appropriate to designate the detection limits as exceeding MCLs.

USEPA Follow-up Comment

Similar to the acknowledgement of detection limits in excess of screening levels performed during the work plan stage, some type of recognition of elevated detection limits in excess of the MCLs needs to be incorporated into Figure 2-6. Please revise the figure accordingly.

Army Response

Figure 2-6 will be revised to italicize non-detected concentrations for which detection limits exceed screening levels. An explanation of the italicized values will be provided in the legend.

Responses to Missouri Department of Natural Resources and U.S. Environmental Protection Agency, Region 7 Comments on the Draft Final Feasibility Study Report for the St. Louis Ordnance Plant, Former Hanley Area

June 10, 2010

This document provides Army responses to the Federal Facilities Section of the Missouri Department of Natural Resources (MDNR) Hazardous Waste Program, Missouri Department of Health and Senior Services (MDHSS), and U.S. Environmental Protection Agency, Region 7 (USEPA) comments on the document referenced above. MDNR and MDHSS comments were received by the Army on March 25, 2010, and USEPA comments were received by the Army on April 1, 2010.

Army responses were originally submitted on April 22, 2010. They were discussed among representatives from USACE, U.S. Army Environmental Command (USAEC), 88th Regional Support Command (RSC), MDNR, MDHSS, and USEPA during a teleconference held on May 10, 2010. The responses below reflect the discussions on May 10.

Land Use Controls

During the May 10 teleconference, the project stakeholders discussed the possibility of establishing land-use controls (LUCs) over the following areas of the former Hanley Area:

- Plume C, where the carbon tetrachloride concentration in groundwater exceeds the remediation goal for construction worker exposure; and
- former Building 220 area where vapor intrusion may pose an unacceptable risk to occupants of future onsite buildings.

After the teleconference, the Army obtained concurrence on the LUCs from the USAEC Office of Counsel. The Army will include LUCs as a common element among Alternatives 2, 3, and 4 in the final feasibility study (FS) report. A description of the LUCs is provided in Attachment A to these responses. LUCs are also discussed in the Army's response to USEPA Specific Comment 8.

MDNR General Comments

Comment 1

For the uninformed reader, it may be helpful to place definitions of terms before the reading section or place an asterisk next to or italicize the specific terms to be defined after the section of reading.

Response

The Army acknowledges the comment but recommends these measures for the forthcoming

proposed plan instead of the FS report. The proposed plan, which will be made available for public review and comment, will italicize technical terms on their first mention and include a glossary of terms at the end of the document.

Comment 2

In the cost estimate for alternative 4 in Appendix A there is a listed cost for excavation water management. In the assumptions column of this table it is noted that recovered groundwater (assumingly contaminated) is planned to be disposed of via an onsite sanitary sewer inlet. To do this, approval must be obtained from the St. Louis Metropolitan Sewer District to discharge the water.

Response

The Army will obtain the necessary approvals from the St. Louis Metropolitan Sewer District prior to the remedial action at the former Hanley Area; this will be noted in the FS report. A previous approval to discharge purged groundwater via the sanitary sewer inlet at the former Hanley Area was obtained during the remedial investigation (RI) phase of the project.

Comment 3

The monitoring of Plume C should be included in the annual and 5 year reviews.

Response

Section 3.8.2.4, paragraph 2 provides the following information concerning the inclusion of the monitoring of Plume C in the 5 year reviews:

The 5-year review will focus on vapor intrusion, the only potential risk that will not be actively addressed through remedial action, and monitoring results associated with Plume C to confirm that the construction worker risk exposure remains unchanged.

Section 3.8.2 also states that groundwater samples will be collected at Plume C annually for a period of five years. Clarifying text will be included in the last sentence of paragraph 2 in Section 3.8.2:

For cost estimating, it is assumed that groundwater samples and depth to water measurements will be conducted annually for the first 5 years, followed by a reduced monitoring frequency of every 5 years.

In addition, the header "*Groundwater Monitoring at Plume A – Year 1 through 5*" in the cost estimate for each alternative will be revised to say "*Groundwater Monitoring at Plumes A and C – Year 1 through 5*".

MDNR Specific Comments

Comment 4

Table 3-12 *Detailed Evaluation of Remedial Alternatives,* Page 4: In the row "Time until protection is achieved" alternatives 2-4 each state that protection would be achieved immediately. For this to be true all contaminated soils would have to be remediated to below screening levels immediately. Due to the roads and utilities around the contaminated soils this would not be possible. It is suggested that the word immediately not be used here to describe the time until protection is achieved. Perhaps terms such as rapidly or promptly would suffice as replacement

adjectives.

Response

Groundwater contamination under Stratford Avenue will not be addressed during the remedial action, therefore, the text referenced in Table 3-12 will be revised for Alternatives 2, 3, and 4, as follows:

Due to the existing ordinance and depth to groundwater, protection would be achieved rapidly onsite. Groundwater contamination under Stratford Avenue will not be addressed during the remedial action, therefore protection would not be achieved rapidly offsite.

MDHSS Specific Comments

Comment 5

Section 2.3.4 Vapor Intrusion states that the potential for vapor intrusion was assessed by collecting indoor and ambient air samples and that no risk to residents was identified based on the measured concentrations of contaminants in the indoor air samples. MDHSS recommends that wording in this section be revised to be consistent with the wording provided in the Executive Summary of the Remedial Investigation Report. Furthermore, this should document that this was only a limited evaluation to address immediate concerns of the potential for vapor intrusion in offsite residences and should qualify that offsite vapor intrusion risks based on indoor air sampling is representative only for potential current exposures. This should further discuss the potential that vapor intrusion risks may become higher in the future due to contaminant migration in groundwater. Additionally, this section should go on to state that potential future vapor intrusion risks both onsite and offsite were not quantified in the human health risk assessment, but rather it was acknowledged that future indoor air exposures are expected to be unacceptable.

Response

As summarized in the RI report, vapor intrusion from groundwater to indoor air may occur at future onsite residences, but such risks could not be quantified because of the shallow groundwater. Based on the high groundwater concentrations onsite (well above groundwater-to-indoor air screening levels) and shallow groundwater, it is expected that unacceptable future risk would be possible at future onsite residences. However, the RI report did not identify unacceptable risk to future offsite residences if concentrations of elevated chemical concentrations remained constant over time. If the VOC plume expands in the future, indoor air concentrations at offsite residences could increase; in that case, future risk presented in the HHRA may be underestimated for offsite residents.

The Army agrees that clarifying text should be included in the report to be consistent with the wording provided in the Executive Summary of the RI report. A new section (2.5.3) titled "Indoor Air" will be provided under Section 2.5 (Human Health Risk Assessment Summary) of the FS report. Text in existing Section 2.3.4 (Vapor Intrusion) under Section 2.3 (Nature and Extent of Contamination Summary) will be expanded as described below.

Section 2.3.4, under the Nature and Extent of Contamination Summary, will be rewritten as follows:

A vapor intrusion investigation and indoor air investigation were conducted in March 2008, in the residential area north of the site, across Stratford Avenue, to assess potential vapor intrusion associated with subsurface groundwater contamination, specifically, PCE, TCE, cis-1,2-DCE, trans-1,2-dichloroethene, vinyl chloride, and 1,2-DCA. The scope of work included soil gas sampling, indoor and ambient air sampling, and groundwater sampling.

After several attempts to collect soil gas samples near the residences north of the site and subsequent discussions with USACE and MDNR on March 21, 2008, it was determined that soil gas samples could not be collected because of tight expansive clays. Therefore, only indoor air and ambient air samples and groundwater samples were collected during the March 2008 investigation.

A teleconference was held on April 22, 2008, among the U.S Army Corps of Engineers (USACE), U.S. Army Environmental Command (USAEC), 89th RRC, USEPA, MDNR, Missouri Department of Health and Senior Services (MDHSS), and CH2M HILL to discuss the March 2008 vapor intrusion investigation results and seek resolution to comments provided on the RI Work Plan (CH2M HILL 2009a). During the meeting, MDHSS expressed concern that sub-slab samples would need to be collected in order to completely assess the indoor inhalation pathway. USEPA explained that the most accurate data to assess indoor inhalation risk would be indoor air samples collected in the basement of the residences, particularly within the residence located at 6317 Stratford Avenue. The residence is downgradient of the groundwater contaminant plume, vacant, and does not contain sources that would affect volatile organic compound (VOC) concentrations in the indoor air samples. Concurrence on the approach was achieved following USEPA's explanation.

One indoor air sample, collected in March 2008 contained TCE above the low end of the acceptable risk level. Based on this result, an additional round of air samples was collected in May 2008. Results from the May 2008 samples indicated no inmediate unacceptable risks to residents.

The new Section 2.5.3, under the Human Health Risk Assessment Summary, will be presented as follows:

As noted in Section 2.3.4, tight expansive clays prohibited the collection of soil gas samples. Therefore, the potential for vapor intrusion was assessed by collecting indoor and ambient air samples on two occasions from the vacant residence at [redacted]*. One indoor air sample, collected in March 2008, contained TCE above the low end of the acceptable risk level. Based on this result, an additional round of air samples was collected in May 2008. Results from the May 2008 samples indicated no immediate unacceptable risks to residents.*

In the area downgradient from former Building 220 (Figure 2-6), Vapor intrusion from shallow groundwater to indoor air may occur at future onsite residences. This exposure pathway cannot be quantified, however, because the groundwater in the area is too shallow (less than 5 feet bgs) to use the Johnson and Ettinger Model (JEM). It is expected that future indoor air exposures in onsite buildings constructed in the area would be at unacceptable levels because of the high concentrations (well above groundwater-to-indoor air screening levels) and shallow groundwater depths.

An assumption was made in the HHRA (CH2M HILL 2009a) that the concentrations of chemicals in the media evaluated remain constant over time. This assumption could over- or underestimate risk, depending on the degree of chemical degradation or transport to other media. For instance, if the VOC plume expands in the future, indoor air concentrations at offsite residences could increase; in that case, future risk presented in the HHRA may be underestimated for offsite residents.

Comment 6

Section 3.3 Preliminary Remediation Goals – This section should briefly discuss the target carcinogenic risk level and the target hazard quotient to be used in setting preliminary remediation goals (PRGs) for the chemicals of concern (COCs).

Response

Text will be added to the introduction of Section 3.3 indicating that soil PRGs for direct contact exposures will be based on a target ELCR of 1×10^{-5}, target HI of 1.0, background UTL for arsenic, and "to be considered" ARAR for Aroclor 1260. Risk-based groundwater PRGs for direct contact exposures by construction workers will be based on the same target risk levels.

Comment 7

Section 3.3.1 Soil presents PRGs for COCs in soil. Please note the PRG value for arsenic is incorrectly listed as 13.2 mg/kg – this should be modified to 12.3 mg/kg.

Response

In Table 3-2, the arsenic PRG is listed as 12.3 milligrams per kilogram (mg/kg) is incorrect; the correct value should be 13.2 mg/kg as explained in the following paragraphs.

In the final RI report (CH2M HILL 2009), an arsenic screening level of 12.3 mg/kg was developed using background samples collected from the St. Louis Army Ammunition Plant (SLAAP). As acknowledged in the February 8, 2010, cover letter for the final RI report, MDNR and USEPA expressed concern over the use of this screening level in the RI.

During a conference call on January 22, 2010, the Army, MDNR, and USEPA agreed on an approach for developing a PRG for arsenic for the FS. Per the agreement, the Army calculated an arsenic PRG following methods used in the February 2005 Final Background Characterization for Lake City Army Ammunition Plant (LCAAP), incorporating updated USEPA recommendations (e.g., ProUCL approaches to calculating background threshold values). The development of the arsenic PRG is presented in Section 3.3.1.1 of the FS. Probability plots are presented in Appendix B.

Using the methods agreed upon on January 22, 2010, a sample population of soil arsenic concentrations from the former Hanley Area (instead of SLAAP) was developed, outliers were removed, probability plots were constructed, and an upper tolerance limit (UTL) was calculated from the values below the inferred inflection point. The outcome of the evaluation was a UTL of 13.2 mg/kg.

The correct arsenic PRG of 13.2 mg/kg will be presented in Table 3-2 of the FS report.

Per the Army's response to USEPA Comment 9, the Army will provide additional backup documentation of the statistical analysis used to develop the arsenic PRG in the FS report.

Comment 8

Section 3.3.2 Groundwater presents PRGs for COCs in groundwater. Groundwater PRGs for carbon tetrachloride (CT) and tetrachloroethene (PCE) are established based on construction worker dermal contact with COCs in groundwater. In addition, although the human health risk assessment did not identify risks from soil for these contaminants, the Feasibility Study (FS) establishes soil PRGs for these contaminants for soil leaching to groundwater based on the

risks from construction worker dermal contact with groundwater. This is not standard practice and MDHSS questions this approach. Soil leaching to groundwater concentrations are developed to address a continuing source of contaminants to groundwater and are traditionally developed to return groundwater to a usable state.

Response

It is standard practice in risk assessment to first identify the target groundwater concentrations based on realistic exposure scenarios and then identify soil concentrations that are protective of cross-media transfer (i.e., soil leaching to groundwater). Potable use is not a realistic future use of site groundwater. St. Louis City Ordnance 66777 prohibits the installation of potable water wells within the City limits. Additionally, groundwater is not expected to migrate outside of the protected limits of the City (groundwater flow is towards the City, not away) and the selected remedial alternative is expected to decrease concentrations well below the construction worker PRG.

For the reasons noted above, no change to the approach is warranted. The Army will address concentrations of groundwater and soil COCs above construction worker PRGs to prevent these media from posing unacceptable risks to construction workers.

Comment 9

Section 3.4.4 Vapor Intrusion & Section 3.8.2.3 Vapor Intrusion Evaluation - Section 3.4.4 Vapor Intrusion states that because of the uncertainty associated with this exposure pathway, the remedial design and remedies will include a vapor intrusion evaluation. Section 3.8.2.3 Vapor Intrusion Evaluation states that as part of this evaluation, there are plans to include monitoring of contaminants in groundwater. The FS goes on to state that because vapor intrusion is an evolving field, groundwater sampling may be replaced with modeling or other sampling methods as new technologies become available. While MDHSS understands that the vapor intrusion pathway is an evolving field and will be evaluated further as part of the site remedy, one of the Remedial Action Objectives (RAOs) is to prevent unacceptable risk both onsite and offsite from potential vapor intrusion to indoor air. The discussion regarding groundwater monitoring lists screening levels based on maximum contaminant levels (MCLs) and on resident risk-based levels for potable use MCLs and risk-based levels for potable use do not take into account the vapor intrusion pathway. As such the FS should establish PRGs for groundwater to be protective of indoor air.

In addition, it is noted that details of the vapor intrusion groundwater monitoring program will be provided in the remedial design and that for cost estimating, it is assumed that groundwater samples would be conducted annually for the first 5 years, then once every five years. Conducting sampling once a year for the first five years does not seem adequate especially given that this pathway has not been completely assessed. MDHSS recommends that the sampling interval be increased to at least a minimum of one year of quarterly groundwater monitoring to establish groundwater trends, followed by annual sampling during the remainder of the first five years.

MDHSS would also like to remind the Army that it was previously stated in the response to comments on the RI report, that the FS would include a discussion on triggers that may warrant vapor mitigation. No such discussion is included. The document simply states that if the

evaluation concludes there is risk, additional sampling or mitigation actions may be implemented. To ensure the protection of human health in the interim, a discussion should be included in the FS that details triggers that may warrant immediate actions to ensure exposures are not occurring.

The document does state that notification will be given to property owners of potential vapor intrusion risk. Please note that MDHSS has recently developed a fact sheet that may be provided to area residents to assist in addressing resident questions and concerns related to vapor intrusion. A copy of this fact sheet is attached.

Response

The RI report did not identify COCs based on the vapor intrusion pathway as explained in the response to MDHSS Comment 5. The 2006 Army Interim Vapor Intrusion Policy states that the Army will only address vapor intrusion risk to current receptors. As noted in the RI report, no vapor intrusion risk currently exists at the former Hanley Area. For anticipated regulatory and anticipated community acceptance, the Army agreed to include vapor intrusion evaluations as part of each remedial alternative although no risk was identified. The FS defaults to groundwater monitoring as a reasonable method for future evaluation for vapor intrusion. A more aggressive action is not warranted because subsurface soil gas samples could not be collected at the site during the RI due to tight, expansive subsurface soils, which is a line of evidence that suggesting limited vapor migration.

For groundwater monitoring, USEPA maximum contaminant levels (MCLs; and site-specific levels for chemicals without MCLs) were selected as "screening levels", rather than PRGs, per se, for the purpose of conducting the vapor intrusion evaluation. This was done to comply with the current Army policy and to prevent the Army from being required to monitor the site until these levels are achieved in groundwater, in the event that future vapor intrusion studies suggest that there is no unacceptable human health risk associated with vapor intrusion. This approach is consistent with Army policy and has been applied at another MDNR Federal Facilities site in Missouri.

Annual groundwater monitoring for the first five years is adequate given the site lithology (tight, expansive clay), low hydraulic conductivity of the unconsolidated formation, limited migration of groundwater contamination because of the low hydraulic conductivity, and similar groundwater results observed in 2007 and 2008. These factors suggest that seasonal fluctuations in groundwater concentrations are minimal.

Because uncertainty exists regarding the vapor intrusion pathway, the Army agrees with the reviewer that groundwater concentration trends should be assessed, particularly along the downgradient edge of the groundwater plume. Because of the plume's age (greater than 30 years) and the limited extent of groundwater contamination over that time, the Army maintains that plume stability is better assessed on an annual basis over a five-year timeframe. These five events, coupled with groundwater monitoring performed in 2007 and 2008 and scheduled for 2010, will provide an adequate assessment of plume stability for the purpose of evaluating possible future vapor intrusion risks.

The Army agrees that Section 3.8.2.3 does not go into detail concerning triggers that may warrant additional sampling and/or mitigation actions. The fourth paragraph in Section 3.8.2.3 (beginning at Line 25 of the Draft Final FS) will be revised as follows:

"COC concentrations above the screening levels will be used as a trigger for determining whether additional sampling and/or mitigation actions are necessary. If groundwater concentrations exceed screening levels and are found to increase along Stratford Avenue, or if other vapor intrusion evaluation measures conclude that there is risk to human receptors, additional sampling or mitigation actions, such as vapor barriers or in-home mitigation systems that vent indoor air to the atmosphere, will be implemented. In accordance with Army vapor intrusion policy, proper notification will be given to current property owners (onsite and offsite) of potential vapor intrusion risk."

Through annual monitoring, the Army will confirm that the baseline groundwater conditions (i.e., distance versus concentration from the source) under which offsite indoor air was monitored remain the same or decrease. Based on the shallow depth to groundwater in the vicinity of the homes along Stratford Avenue (less than 5 ft bgs), USEPA's empirical (measured) attenuation factors (from soil gas to indoor air) and the Johnson and Ettinger Model cannot be used to back-calculate target groundwater concentrations protective of indoor air. Although the MCL was not developed with the vapor intrusion pathway in mind, it is assumed to be overly conservative (i.e., protective) for the vapor intrusion pathway since USEPA has determined, on a federal level, that MCLs are protective of inhalation exposures in the shower, which are more intensive inhalation exposures than those that may result from groundwater volatilization and subsequent intrusion through a building foundation.

The Army appreciates the fact sheet that MDHSS provided with this comment.

USEPA Specific Comments

Comment 1

Acronyms and Abbreviations and Section 1.3: NCP stands for National Oil and Hazardous Substance Pollution Contingency Plan.

Response

The term for the acronym "NCP" will be revised accordingly.

Comment 2

Section 2.0: What extent of statistical trend analysis has been performed for the multiple years of groundwater data to evaluate if the site plumes are increasing, decreasing, stable, or if there is no observable trend?

Response

During the RI, a plume stability analysis was performed using the REMChlor model. Please refer to Section 2.4.4 in the Draft Final FS report for a discussion of the modeling findings.

Comment 3

Section 2.3: On page 2-2, line 38 mentions that the Job Corps denied access in further delineating surface soil contamination toward the west of the Hanley Area. However, the Department of Labor (DOL) and EPA took soil samples and DOL removed soils and is in the process or has redeveloped the area to provide additional housing for the Job Corp. Please expand the discussion in this section of the work conducted in this area.

Response

To address this comment, reference to the sampling on the Job Corps property will be removed from Section 2.3 (Nature and Extent Summary) and added to Section 2.3.1 (Surface Soil). The first paragraph of Section 2.3.1 will be replaced with the following text:

Surface soil contamination (0 to 2 feet below ground) across the former Hanley Area consists primarily of metals. Antimony, arsenic, chromium, copper, lead, thallium, selenium, and silver were detected at concentrations greater than the corresponding screening levels in surface soil (Figure 2-4). These metals were delineated during previous investigations, with the exception of arsenic at the western property boundary adjoining Job Corps property. To fill this data gap, the U.S. Department of Labor collected six soil samples on their property in the area adjoining the elevated arsenic concentrations. On September 28, 2009, USEPA collected two split surface soil samples and analyzed them for metals. Arsenic concentrations of 7.4 and 7.2 mg/kg were measured in these samples.

The text above can be expanded to discuss results from the Department of Labor samples, once those results become available.

Comment 4

Section 2.3.5, Page 2-4: Add a sentence or two that summarizes the levels of contamination to be addressed as part of the powder well sediment removal action.

Response

As stated in Section 2.3.5, sediment will be removed from the powder wells as part of the remedial action. The levels of powder well sediment contamination are not relevant because the remedial action will remove the sediment in the powder wells. Sediment samples will be collected for waste characterization purposes only.

Comment 5

Section 2.5.2: Has the city of St. Louis provided a written letter assuring that they will monitor and enforce City Ordinance 66777 prohibiting the installation of potable water supply wells? Please include this reference in the text or obtain proof from the city.

Response

On August 1, 2005, the City of St. Louis approved Ordinance 66777. The Ordinance prohibits the use or attempted use of groundwater as a potable water supply and the drilling or installation of wells to be used for a potable water supply within the corporate limits of the City of St. Louis. Further, the Ordinance authorizes the Mayor of the City of St. Louis to enter into a Memorandum of Understanding (MOU) with MDNR with regard to the Ordinance.

On October 25, 2006, the City of St. Louis and MDNR entered into the MOU referred to in Ordinance 66777. The intent of the MOU is to specify the roles and responsibilities of the City and MDNR and to specifically satisfy the requirements for MOUs. Under the MOU, the City's responsibilities include the following:

- The City will notify MDNR of proposed changes to Ordinance 66777 or requests for variance at least 30 days prior to the date that the local government is scheduled to take action on the proposed change or request.

- The City will enforce the ordinance and notify MDNR when the ordinance is violated.
- The City will allow MDNR access to information necessary to monitor adherence to the terms of the MOU or the ordinance.

Reference to the MOU and the City's role in monitoring and enforcing Ordinance 66777 will be added into the FS report. Please refer to the Army's response to USEPA Specific Comment 8.

Comment 6

Figure 2-6: MW-110 shows detection limits in excess of maximum contaminant levels (MCLs). Please revise the results for this well to bold and shadow these detection limits.

Response

The Army acknowledges that detection limits for some undetected chemicals in MW-110 and other monitoring wells exceeded screening values for groundwater. Such instances occurred in samples that were diluted during analysis because of elevated concentrations of other VOCs. Because uncertainty exists regarding whether the non-detected chemicals are actually present at levels above MCLs, it is not appropriate to designate the detection limits as exceeding MCLs.

Comment 7

Figure 2-6: The list of MCLs has the incorrect values for cis-1,2-DCE and naphthalene, and it appears that these values have been reversed. Please revise accordingly.

Response

The value for cis-1,2-DCE will be revised (70 µg/L). In addition, the MCL for PCE (5 µg/L) will be included in Figure 2-6.

Comment 8

Sections 3.2 and 3.8: Section 3-2,-third paragraph, states that St. Louis Ordinance 66777 is already in place as an institutional control. This "institutional control" needs to be incorporated as part of each alternative and discussed in Section 3.8 with the other common alternative elements. Please revise accordingly.

Response

St. Louis Ordinance 66777, which prohibits the installation of potable use water supply wells within the City limits, will be included as a common element for Alternatives 2, 3, and 4. During the March 23, 2010 meeting, the Army, MDNR, and USEPA agreed to pull the common elements of Alternatives 2, 3, and 4 into a stand-alone section. A new section (3.8.2), titled "Common Elements Among Alternatives 2, 3, and 4" will be included after Section 3.8.1, "Alternative 1 – No Action". Section 3.8.2 will include the following subsections:

- Soil and Powder Well Sediment Removal (corresponds to existing subsection 3.8.2.2 of the draft FS report)
- Vapor Intrusion Evaluation (corresponds to existing subsection 3.8.2.3 of the draft FS report)
- Five-Year Reviews (corresponds to existing subsection 3.8.2.4 of the draft FS

report)

A new subsection titled "Land Use Controls" will be included as a common element among Alternatives 2, 3, and 4. This subsection will describe Ordinance 66777 using information provided in the Army's response to USEPA Specific Comment 5, and it will include the LUC descriptions provided in Attachment A of these responses.

The subsequent sections discussing Alternatives 2, 3, and 4 will only cover the groundwater treatment portion of the remedy.

Comment 9

Section 3.3.1.1, Pages 3-4 through 3-6: The second paragraph of Section 3.3.1.1 describes the procedures associated with the development of the arsenic preliminary remediation goal (PRG) as follows: "In accordance with the January 22, 2010 teleconference, the Army completed the following steps to develop a PRG for arsenic in soil: Select a sample population ... Construct a probability plot ... Calculate the upper tolerance limit from the concentrations below the inflection point value." However, the "Recommended Path Forward for Former Hanley Area" memo submitted with the Final Remedial Investigation (RI) Report states "Although the plot lacks a single clearly-defined inflection point, it does not refute the use of the 95/95UTL of 12.3 mg/kg for arsenic for screening purposes in the RI or as a PRG in the FS. For this reason, 12.3 mg/kg should be retained as the background-based PRG for arsenic in the FS." Clearly, the steps laid out during the January 22, 2010, meeting should have been followed yet the report does not provide any backup documentation to this effect. To add confusion, the second paragraph of Page 3-6 states the calculated UTL of 13.2 mg/kg will be used as the PRG for arsenic in soil, while Table 3-2 shows 12.3 mg/kg as the Final arsenic PRG.

a. Was a new PRG calculated as described in the text of this FS?

b. If so, please provide the Pro-UCL backup documentation for the calculation.

c. Please provide documentation of the outlier test that was performed.

d. Please reconcile the appropriate arsenic PRG in both the text and tables.

Response

Please note that the document entitled "Recommended Path Forward for Former Hanley Area" was superseded by the agreements reached among MDNR, USEPA, and the Army during the January 22, 2010 teleconference. The details of the agreed-upon approach are provided in the Army's response to MDHSS Specific Comment 7. As noted, the Army followed the approved approach to develop a UTL of 13.2 mg/kg for soil. Table 3-2 is in error and will be corrected to reflect a PRG of 13.2 mg/kg.

a) Please refer to Response to MDHSS Specific Comment 7.

b) ProUCL output is provided in Attachment B. In the presence of nondetects, ProUCL attempts to calculate a UTL based on maximum-likelihood-estimate (MLE) proxies for the nondetects. For instance, it will attempt to attribute proxy values for the nondetects that will optimize fit to the distribution ProUCL otherwise chose. When a UTL based on MLE proxies is available, it is preferred (per discussion in ProUCL Technical Guide; USEPA,

2009) to a UTL calculated using proxy values for nondetects of the detection limit divided by 2 (DL/2). Thus for arsenic, the MLE Normal UTL was recommended from ProUCL.

c) Visually, two elevated results (23.5 and 36.3 mg/kg) appeared unusual relative to the rest of the data. These two values were the only values identified as mathematical outliers using Rosner's outlier test. No other values in either the elevated or lower tail of the concentrations were concluded to be mathematical outliers. These two were excluded from the data used to prepare the probability plots. An outlier evaluation of the chosen background detected values (11.7 mg/kg and lower) revealed no outliers. ProUCL output is provided in Attachment B.

d) Please refer to response to MDHSS Specific Comment 7.

Comment 10

Section 3.3.2.1, Page 3-6: The text states that "Risks were not identified for soil containing CT and PCE." This is unclear – were risks not calculated or just present at acceptable levels? Please clarify.

Response

The text in Section 3.3.2.1 will be clarified to indicate that carbon tetrachloride was not a chemical of potential concern (COPC) due to low concentrations (below screening levels) and PCE was a COPC, but risk estimates were within USEPA acceptable levels.

Comment 11

Section 3.8.2.4: At most CERCLA sites, five-year reviews continue beyond the time when the cleanup standards are achieved to ensure that the remedy and institutional controls are protective. This section is unclear on the conditions for terminating the five-year reviews. Also, concurrence from the Missouri Department of Natural Resources and EPA is needed prior to .termination of the five-year review.

Response

Five-year site reviews will be conducted until hazardous substances are at or below concentrations that allow unlimited use and unrestricted exposure. Additional clarification will be added to the first paragraph of Section 3.8.2.4, starting with the second sentence, as follows:

"*The five-year reviews will be terminated once the following occur:*

- *COCs are at or below the remediation goals*
- *the vapor intrusion pathway is determined not to cause unacceptable risk as part of a future vapor intrusion evaluation (or chemical concentrations in groundwater fall below screening levels),*
- *monitoring confirms that no unacceptable risks are posed by Plume C. Confirmation will consist of demonstrating that groundwater in Plume C remains deeper than 10 feet below the ground surface or that concentrations within the plume have fallen below remediation goals.*

Once these conditions are confirmed at the former Hanley Area, the five-year reviews will be terminated with approval of MDNR and in consultation with USEPA."

Comment 12

Section 3.8.3: Please provide the citations for the four Department of Defense sites in line 9 on page 3-17.

Response

The sentence in Section 3.8.3 beginning in Line 8 on page 3-17 will be revised as follows:

This process has been successfully applied at the field-scale at various sites since 2002, including four Department of Defense sites and one industrial site, at depths up to 35 feet below ground. The following are examples of soil mixing projects completed to date:

- *At Camp Lejeune, North Carolina, ZVI-clay soil mixing was performed on 7,000 cubic yards of soil at a former dry cleaner site in 2005. Soil PCE concentrations at the site decreased by 91 percent within one year after treatment (Bozzini et al. 2008).*
- *Also at Camp Lejeune, ZVI-clay soil mixing was performed on 30,000 cy of soil at a Defense Reutilization and Marketing Office site in 2008. After one year of monitoring, mean and median contaminant concentrations in soil decreased by over 99 percent. After one year of monitoring, median contaminant concentrations in groundwater decreased in source area monitoring wells by 99.99 percent, with mean contaminant concentrations in groundwater decreasing by 92.3 percent (AGVIQ-CH2M HILL Joint Venture I 2010).*
- *At a site at Arnold Air Force Base, Tennessee, soil mixing was performed on 1,600 cy of soil. Site monitoring is currently in progress.*
- *At a former Army post in Warrenton, Virginia, ZVI-clay soil mixing was performed on 1,200 cy of soil in 2006. Groundwater sampling demonstrated a 99.95 percent reduction in contaminant concentrations within 15 months. Contaminant concentrations in soil decreased below detection limits (Ruffing et al. 2008).*
- *At a private industrial site in South Carolina, ZVI-clay soil mixing was performed on 1,200 cy of soil. Site monitoring is currently in progress.*

This process is practicable and implementable at the former Hanley Area and is compatible with the clayey soils found at the site.

The following references will be added to Section 5 of the FS:

Bozzini, C., Skean, J., Tiburzi, M., Tysor, G., Lowder, B. 2008. *DNAPL Remediation at Camp Lejeune Using ZVI-Clay Soil Mixing.* Presented at the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA.

AGVIQ – CH2M HILL Joint Venture I. 2010. Non-time-critical Removal Action Report, Site 89, Operable Unit 16, Marine Corps Base Camp Lejeune, North Carolina. March

Ruffing, S., Pike, C., Speranza, M., Flaherty, N. 2008. *Remediation of Chlorinated Hydrocarbons Utilizing Zero Valent Iron via Soil Mixing.* Presented at the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, Monterey, CA.

Comment 13

Table 3-4: This table needs to include references for the empirical data presented therein. If the

values are based on professional judgment, then indicate as such.

Response

Table 3-4 will be modified to indicate that USEPA's *Risk Assessment Guidance for Superfund. Vol.1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment)* is the source of the chemical-specific values and USEPA's IRIS database is the source of the toxicity values.

Comment 14

Table 3-4: This table shows equations for the calculation of Z which is the dermal factor and one of the many inputs for the PRG equations. However, while the other inputs are identified at the bottom of the table, the calculated Z values have not been included. The table needs to be revised to show the Z values.

Response

The calculated Z values will be added to Table 3-4.

Comment 15

Table 3-5: The PRGs for CT and PCE for this FS appear to be the same as the SSLs. Please provide additional explanation in terms of equations that shows how the VOC Soil PRGs were calculated.

Response

The soil PRGs for protection of groundwater were calculated using the equation and input parameters presented in Table 3-6, assuming a dilution and attenuation factor of 1 (i.e., no dilution or attenuation).

Comment 16

Table 3-9: A large number of technologies were not retained for further due ineffectiveness as a result of the site's fine-grained soils. However, Monitored Natural Attenuation (MNA) was not retained due to the time required to reduce concentrations to PRGs. Even in light of the concerns with the length of time, MNA still appears to be a viable option and consideration should be given to its retention as a technology.

Response

The RI concluded that MNA is not a viable option, as stated below:

"The principal destructive fate mechanism for cVOCs is likely to be biodegradation. Biological [reductive dechlorination] RD is usually the principal cVOC biodegradation process in groundwater systems, and there is evidence of RD occurring at this site. The evidence is the presence of RD biotransformation products: (a) TCE, cis-1,2-DCE, and vinyl chloride indicating RD of PCE in Plume A; and (b) chloroform indicating RD of CT in Plume C. Geochemical parameter data (Table 6-2) do not provide much supporting evidence for RD at the site. The DO and ORP data indicate generally aerobic/oxidizing conditions, which are not favorable for RD. It is not unusual to observe some breakdown product evidence of RD under these conditions, because anaerobic microsites can exist even when the bulk groundwater is

aerobic; however, the extent of cVOC breakdown is usually limited at such sites. Further, the geochemical data show little or no evidence of iron reduction, sulfate reduction, methane production, or formation of ethane/ethene (complete dechlorination end products). There is, however, evidence of manganese reduction, suggesting that redox conditions may be appropriate for RD of CT to chloroform (although possibly not further along the breakdown pathway). Aerobic biodegradation of susceptible cVOC compounds (e.g., 1,2-DCA, benzene, naphthalene, vinyl chloride) might also be occurring, but this cannot be determined from the available data.

As stated in Table 3-9 of the FS report, site conditions are not favorable for reductive dechlorination.

Comment 17

Table 3-9: Under description for chemical reduction, there is a missing beginning parenthetical.

Response

The missing beginning parenthetical will be included.

Comment 18

Table 3-11: If an alternative produces a hazardous byproduct (such as PCE transforming to TCE through dechlorination), then this should be added to this table as well.

Response

The degradation compounds vinyl chloride and methylene chloride and the corresponding MCLs of 2 and 5 µg/L, respectively, will be added to Section 3.8.2.3. Other degradation products (e.g., TCE and cis-1,2-DCE) are already included in Table 3-11.

Comment 19

Table 3-13: The cost differential between Alternative 2 and Alternatives 3 and 4 does not seem to correlate with a scoring differential of 1 and 3. Consider changing the Alternative 2 score 2.

Response

The scoring for Alternative 2 cost criteria will be revised to 2. The total score for Alternative 2 will be updated to reflect the change to the cost score.

Comment 20

Figure 3-1: Due to the scale of the figure, it appears that some of the soil removal areas do not encompass some of the contaminated boring locations (ex. SS-218A-1) to be remediated. Consider adjusting the scale and showing the soil removal areas on separate 8 ½ x 11 portrait figures so that the reviewer can more easily determine if the soil samples in question are captured by the proposed soil removal areas.

Response

On Figure 3-1, two composite soil sample locations (SS-218A-1 and SS-218A-3) do not have excavation limits drawn around one or more of the component samples that make up the composite sample. The figure will be revised to show estimated removal action boundaries

around each component sample for SS-218A-1 and SS-218A-3. Additional details regarding the soil removal action areas will be provided in the remedial design/remedial action work plan for the former Hanley Area.

Comment 21

Figure 3-1: Boring SS55A appears to be located along the fence line. Based on the suspected timing of the PCB-1260 release at this site and the timing of the installation of the fence, there is a possibility that contamination at the location in question extends south beyond the fence. It is recommended that delineation efforts address the extent of possible PCB-1260 contamination on the south side of the fence.

Response

The U.S. Toxic and Hazardous Materials Agency 1991 Status Report indicated that the leaking transformer was demounted and protectively wrapped in spring of 1991. The transformer and underlying soil was disposed of by the U.S. Army Engineer Center and Fort Leonard Wood. Inspection of the ground under the location of the transformer revealed that the area was asphalt and had become slightly covered with soil. The transformer fluid was observed to be highly viscous and had not mixed with precipitation or runoff. It was also observed that the viscous nature of the fluid had caused dust, soil, and vegetation to adhere to it.

However, as part of the remedial design investigation summarized in Section 3.8.2, soil samples will be collected to delineate the presence of Aroclor 1260. The soil samples will be collected on the south side of the fence if needed to delineate the southern extent of Aroclor 1260 above the PRG.

Comment 22

Appendix A:

a. In the common elements section for all alternatives, an estimate should be provided for monitoring Plume C.

b. Under the five-year box for all the alternatives, the quantity and unit are reversed and the source description was cut off.

c. Under Groundwater Monitoring at Plume A – Year 1 through 5, the description should say "Total Cost of Alternative 4 with Remedial Design and Contingency"

d. In the box below the comment 22b, the description is missing the end parenthetical.

Response

Comment 22a - Please refer to response to HWP General Comment 3.

Comment 22b - The cost estimates will be revised accordingly.

Comment 22c - The description for Alternative 4 will be revised to say "*Total Cost of Alternative 4 with Remedial Design and Contingency*".

Comment 22d -- The cost estimates will be revised accordingly.

Attachment A – Description of Land Use Controls at Former Hanley Area

Land Use Controls at the Former Hanley Area

Land use controls (LUCs) will be implemented onsite at the former Hanley Area in areas where groundwater concentrations exceed screening levels, unless future vapor intrusion evaluations confirm that risk thresholds have not been exceeded. The LUCs will require vapor intrusion evaluations at building construction sites if groundwater concentrations have not fallen below screening levels in the vicinity of the construction site. If results of the vapor intrusion evaluation indicate potential vapor intrusion issues, or if a vapor intrusion evaluation is not performed, vapor intrusion mitigation technology will be applied to address soil gases that could enter the future building.

Within the LUC area described above, a second LUC will be established over the Plume C footprint as long as carbon tetrachloride concentrations remain above the groundwater remediation goal. This LUC will prohibit construction activities below the groundwater table without proper health and safety training and personal protective equipment.

Figure 1 presents the LUC boundaries at the former Hanley Area.

The Army will prepare a Land Use Control Implementation Plan (LUCIP) to define restrictions within the LUCs, establish LUC boundaries, and explain how they will be implemented, monitored, and enforced.

Upon transfer of property ownership, the Army will include restrictions in the property deed to memorialize the LUCs defined in the LUCIP. The *Army Defense Restoration Program Management Guidance for Active Installations* (Department of the Army 2004) provides guidelines for conveying LUCs during a property transfer from the Army to a non-federal entity. At sites where a CERCLA hazardous substance has been stored, released or disposed on federal property where the United States sells or otherwise transfers the impacted property, CERCLA Section 120(h)(3) specifically dictates deed covenant language. For property sold or to be otherwise transferred from the United States, the Army will prepare all required deed covenants to comply with CERCLA Section 120(h)(3).

Reference

Department of the Army. 2004. Army Defense Environmental Restoration Program: Management Guide for Active Installations. November.

[redacted]

Attachment B – ProUCL Output for Development of Arsenic PRG

Attachment B - ProUCL Output for Development of Arsenic PRG
Former Hanley Area, St. Louis Ordnance Plant, St. Louis, MO

General Background Statistics for Data Sets with Non-Detects

User Selected Options	
Full Precision	OFF
Confidence Coefficient	95%
Coverage	95%
Different or Future K Values	1
Number of Bootstrap Operations	2000

Arsenic

General Statistics

Number of Valid Data	101	Number of Detected Data	79
Number of Distinct Detected Data	72	Number of Non-Detect Data	22
		Percent Non-Detects	21.78%

Raw Statistics		Log-transformed Statistics	
Minimum Detected	4	Minimum Detected	1.386
Maximum Detected	11.7	Maximum Detected	2.46
Mean of Detected	7.386	Mean of Detected	1.97
SD of Detected	1.817	SD of Detected	0.246
Minimum Non-Detect	0.125	Minimum Non-Detect	-2.079
Maximum Non-Detect	0.688	Maximum Non-Detect	-0.374

Data with Multiple Detection Limits		Single Detection Limit Scenario	
Note: Data have multiple DLs - Use of KM Method is recommended		Number treated as Non-Detect with Single DL	22
For all methods (except KM, DL/2, and ROS Methods),		Number treated as Detected with Single DL	79
Observations < Largest ND are treated as NDs		Single DL Non-Detect Percentage	21.78%

Background Statistics

Normal Distribution Test with Detected Values Only		Lognormal Distribution Test with Detected Values Only	
Lilliefors Test Statistic	0.0826	Lilliefors Test Statistic	0.0463
5% Lilliefors Critical Value	0.0997	5% Lilliefors Critical Value	0.0997
Data appear Normal at 5% Significance Level		**Data appear Lognormal at 5% Significance Level**	

Assuming Normal Distribution		Assuming Lognormal Distribution	
DL/2 Substitution Method		DL/2 Substitution Method	
Mean	5.844	Mean (Log Scale)	1.258
SD	3.347	SD (Log Scale)	1.401
95% UTL 95% Coverage	12.28	95% UTL 95% Coverage	51.93
95% UPL (t)	11.43	95% UPL (t)	36.41
90% Percentile (z)	10.13	90% Percentile (z)	21.18
95% Percentile (z)	11.35	95% Percentile (z)	35.22
99% Percentile (z)	13.63	99% Percentile (z)	91.5
Maximum Likelihood Estimate(MLE) Method		Log ROS Method	
Mean	5.506	Mean in Original Scale	6.677
SD	3.982	SD in Original Scale	2.111
95% UTL with 95% Coverage	13.16	95% UTL with 95% Coverage	11.83
		95% BCA UTL with 95% Coverage	11.4
		95% Bootstrap (%) UTL with 95% Coverage	11.4
95% UPL (t)	12.15	95% UPL (t)	10.89
90% Percentile (z)	10.61	90% Percentile (z)	9.612
95% Percentile (z)	12.06	95% Percentile (z)	10.81
99% Percentile (z)	14.77	99% Percentile (z)	13.48

Attachment B - ProUCL Output for Development of Arsenic PRG
Former Hanley Area, St. Louis Ordnance Plant, St. Louis, MO

General Background Statistics for Data Sets with Non-Detects

Gamma Distribution Test with Detected Values Only	
k star (bias corrected)	16.35
Theta Star	0.452
nu star	2583
A-D Test Statistic	0.205
5% A-D Critical Value	0.751
K-S Test Statistic	0.0503
5% K-S Critical Value	0.1
Data appear Gamma Distributed at 5% Significance Level	
Assuming Gamma Distribution	
Gamma ROS Statistics with Extrapolated Data	
Mean	6.92
Median	6.67
SD	1.906
k star	12.73
Theta star	0.543
Nu star	2572
95% Percentile of Chisquare (2k)	38.23
90% Percentile	9.492
95% Percentile	10.39
99% Percentile	12.21

Data Distribution Test with Detected Values Only	
Data appear Normal at 5% Significance Level	
Nonparametric Statistics	
Kaplan-Meier (KM) Method	
Mean	6.648
SD	2.122
SE of Mean	0.213
95% KM UTL with 95% Coverage	10.73
95% KM Chebyshev UPL	15.94
95% KM UPL (t)	10.19
90% Percentile (z)	9.368
95% Percentile (z)	10.14
99% Percentile (z)	11.59
Gamma ROS Limits with Extrapolated Data	
95% Wilson Hilferty (WH) Approx. Gamma UPL	10.41
95% Hawkins Wixley (HW) Approx. Gamma UPL	10.47
95% WH Approx. Gamma UTL with 95% Coverage	11.06
95% HW Approx. Gamma UTL with 95% Coverage	11.15

Note: UPL represents a preferred estimate of BTV
For an Example: KM-UPL may be used when multiple detection limits are present
Note: DL/2 is not a recommended method.

Attachment B - ProUCL Output for Development of Arsenic PRG
Former Hanley Area, St. Louis Ordnance Plant, St. Louis, MO

Outlier Tests for Selected Variables

User Selected Options

Full Precision	OFF
Test for Suspected Outliers with Dixon test	1
Test for Suspected Outliers for Rosner test	10

Rosner's Outlier Test for all Arsenic Concentrations

Mean	**7.315**
Standard Deviation	**5.366**
Number of data	**116**
Number of suspected outliers	**10**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	7.315	5.343	36.3	116	5.425	3.425	3.795
2	7.063	4.649	23.5	115	3.536	3.422	3.795
3	6.919	4.403	18.9	114	2.721	3.422	3.795
4	6.813	4.274	18.2	113	2.664	3.415	3.785
5	6.711	4.154	16.7	112	2.405	3.415	3.785
6	6.621	4.062	16.5	110	2.432	3.411	3.781
7	6.532	3.968	16.5	111	2.512	3.408	3.778
8	6.44	3.868	15.9	109	2.446	3.405	3.775
9	6.353	3.776	14.5	108	2.158	3.401	3.771
10	6.276	3.71	14.2	107	2.136	3.398	3.768

For 5% significance level, there are 2 Potential Outliers
Therefore, Potential Statistical Outliers are
36.3, 23.5

For 1% Significance Level, there is 1 Potential Outlier
Therefore, Observation 36.3 is a Potential Statistical Outlier

Attachment B - ProUCL Output for Development of Arsenic PRG
Former Hanley Area, St. Louis Ordnance Plant, St. Louis, MO

Rosner's Outlier Test for Selected Background Detections

Mean	**7.386**
Standard Deviation	**1.817**
Number of data	**79**
Number of suspected outliers	**10**

#	Mean	sd	Potential outlier	Obs. Number	Test value	Critical value (5%)	Critical value (1%)
1	7.386	1.806	11.7	79	2.389	3.305	3.665
2	7.331	1.761	11.5	78	2.368	3.295	3.665
3	7.276	1.706	11.4	76	2.417	3.295	3.655
4	7.222	1.649	11.4	77	2.534	3.285	3.654
5	7.166	1.586	11	75	2.416	3.285	3.645
6	7.115	1.532	10.3	74	2.079	3.279	3.641
7	7.071	1.496	4	1	2.053	3.273	3.637
8	7.114	1.461	4.036	2	2.107	3.267	3.632
9	7.157	1.424	10.1	73	2.067	3.261	3.628
10	7.115	1.389	10	71	2.077	3.255	3.624

For 5% Significance Level, there is no Potential Outlier

For 1% Significance Level, there is no Potential Outlier